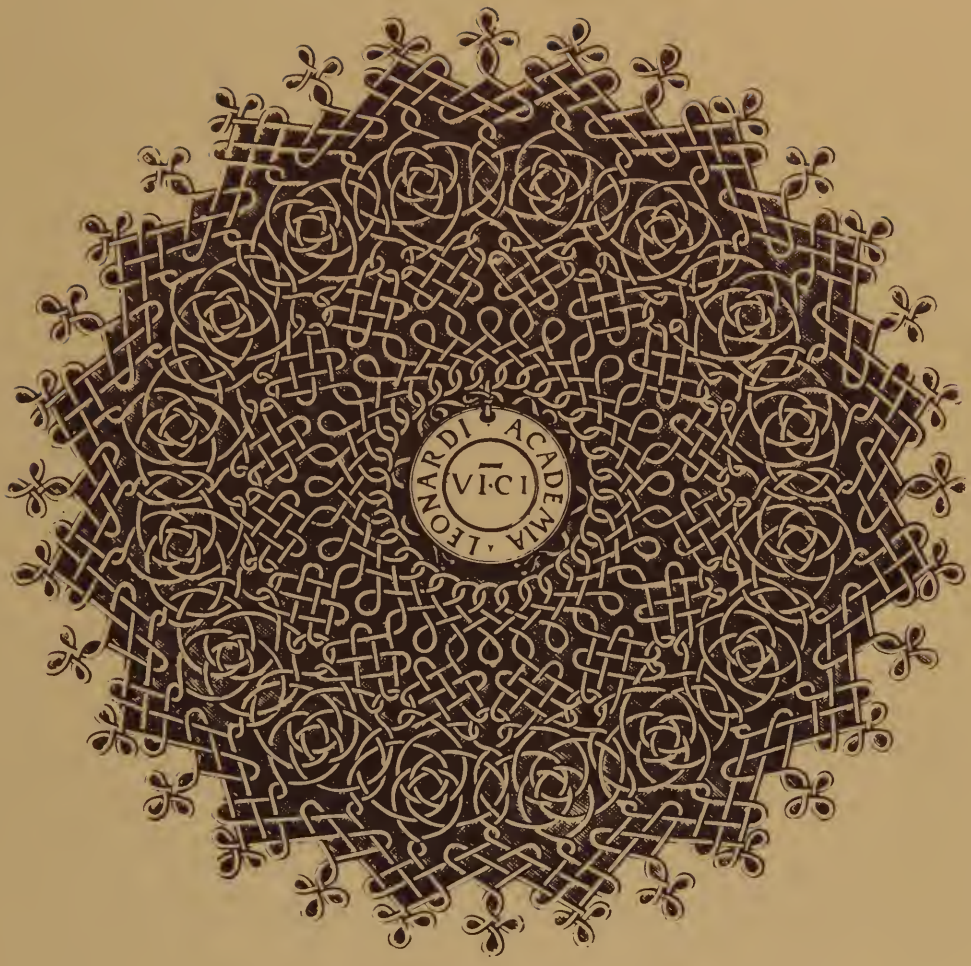

LEONARDO DA VINCI AND MEDICINE

Cover illustration: Detail of a seal for Leonardo's academy, designed between 1490 and 1500. It is thought to represent universal love and nature, to symbolize individuation. Courtesy Lessing Rosenwald collection, National Gallery of Art.

LEONARDO DA VINCI AND MEDICINE

An Exhibit

February 21 - April 30, 1966

NATIONAL LIBRARY OF MEDICINE
Bethesda, Maryland

PREFACE

The National Library of Medicine is pleased to present a new exhibit, "Leonardo da Vinci and Medicine," prepared with the generous assistance and guidance of Raymond S. Stites, Ph.D., Assistant to the Director, for Educational Services, of the National Gallery of Art.

An acknowledged authority on Leonardo, Dr. Stites has given freely of his time in planning the exhibit and in selecting and cataloging the materials on display. The exhibit thus reflects Dr. Stites' interpretation of this outstanding, albeit controversial figure, whose life and work have long been the subject of critical discussion and debate.

The Library welcomes the opportunity to sponsor this exhibit in the hope that it will stimulate broader interest in Leonardo and his influence on the medicine of his day. In addition, it may serve to remind us of the importance of history and medical art in achieving a better understanding of the current state of the medical sciences.

The Library wishes to express its appreciation to the following institutions and individuals:

To Her Majesty Queen Elizabeth II for gracious permission to reproduce drawings in the Library at Windsor Castle;

To the Italian Government for permission to reproduce pages of the *Codex Atlanticus;*

To Dr. John Walker, Director of the National Gallery of Art, for making available the services of Dr. Stites;

To Dr. Elmer Belt, noted surgeon and scholar, for the loan of materials from his personal collection;

To the Library of Congress, the National Gallery of Art, the Elmer Belt Library of Vinciana of the University of California at Los Angeles, the Armed Forces Institute of Pathology Medical Museum, and the Historical Library of the Yale Medical Library for the loan of materials;

And to Dr. Jonathan Hartwell, Dr. R. Burns Ross, Clyde Hall, and M. Elizabeth Stites for their assistance to Dr. Stites.

Finally, the Library is proud of the contributions of its own staff, particularly Robert S. Cohen who coordinated the organization and reproduction of exhibit materials and prepared the overall design of the exhibit.

Martin M. Cummings, M.D.
Director, National Library of Medicine

INTRODUCTION

"On April 15, 1452, a Saturday, at 3:00 a.m., there was born to my son Piero a son, Leonardo da Vinci." So a leading citizen, Antonio di Ser Piero, of the town of Vinci in Tuscany, recorded the auspicious event.

Saturday is Saturn's day, harbinger of a saturnine temperament. Fortunately, April 15 also comes under the more pleasant sign of Aries, the Ram. This combination of signs augured well. Astrologers could have prophesied that young Leonardo would be predisposed to the characteristics associated with Saturn, that he would be artistic, with a tendency toward the melancholic, but at the same time aggressive, intellectually promising, outgoing and friendly, with a highly explorative nature. Actually, Leonardo's notebooks indicate that there was little of the melancholic in his nature until his old age; and as for aggressiveness, his association word lists and other notes seem to prove that he definitely set out to overcome this natural tendency and that he succeeded in sublimating it into scientific research.

In a tax return filed in 1457, Antonio di Ser Piero claimed Leonardo as a member of his household. Little else is known of Leonardo's early life, but several facts support the theory that he grew up on a hillside farm under the care of his mother, Caterina, wife of Achattabrigha di Piero del Vaccha da Vinci, a maker of brick and pottery kilns. Here the boy could strengthen body and mind exploring the marshes and lakes of the valley and climbing the mountains behind his home. Here he would have become acquainted with its many medicinal herbs and with the ochre that was mined for medicines as well as for pigment.

Most scholars presume that Leonardo joined his father's household in Florence by the age of thirteen. Ser Piero was by this time one of the most brilliant notaries of Florence. He must have been intellectually congenial to Leonardo, who had the lawyer's logical manner of thinking, but Leonardo's illegitimate birth prevented him from following his father into the lawyer's guild. Instead, he was apprenticed to the master goldsmith Verrocchio, a jack-of-all-trades who, according to Vasari, was not only interested in sculpture, painting, and mathematics, but was also

one of the first Florentine artists to practice dissection. As a member of the minor Artists' Guild of St. Luke, Verrocchio was also an associate in the major Guild of Physicians and Apothecaries. Thus young Leonardo, having grown up in a town noted for fine medicinal herbs, seemed predestined to spend much of his life in the study of botany, anatomy, and medicine, and in the invention of related devices.

In the development of Leonardo's interest in anatomy, the friendship of Paolo Toscanelli, the Florentine physician, astronomer, cartographer, and member of the Guild of Physicians and Apothecaries, seems to have been especially significant. Leonardo may have witnessed his first anatomical dissections in the monastic hospitals of Santa Maria Nuova or Santo Spirito, where Toscanelli practiced medicine and perhaps taught anatomy. Toscanelli's features may, I believe, be identified in Leonardo's signed drawing, on page 320 v.a. of the *Codex Atlanticus*, of a surgeon carrying what may be recognized as the dissected female reproductive organs. On two other pages of the same codex (379 v.b., 379 r.a.) he shows what may have been an attempt to improve upon the Roman speculum by reversing the action to make another device for holding and breaking bladder stones. In dissection records from these early days he compared tortuous veins in the abdomen of an aged man, so thickened that the passage of blood was hindered, with those in the body of a young child.

Leonardo and Verrocchio collaborated, I am convinced, on the splendid terra cotta bust of Giuliano de' Medici, now in the National Gallery of Art in Washington. Leonardo's part is to be seen, I believe, in the head of Nemesis, goddess of revenge, which decorates Giuliano's cuirass. The anatomical differences between the head of Giuliano, done by Verrocchio, and that of the ferocious Fury, done by Leonardo, demonstrate the more discerning skill and knowledge of the younger man, a superiority detected by some scholars also in the head of Goliath on Verrocchio's statue of David, in the Bargello, Florence. Such skill could have come only after Leonardo had closely studied the action of facial muscles and had become familiar with every detail through dissection. Close examination of the features of Nemesis shows that one of her eyes has slipped upward in a cataleptic trance. This would seem to indicate that Leonardo had been observing the features of the insane or of epileptics. Leonardo's acute observations of physical reactions are also shown on the ecstatic faces of the participants in his unfinished painting of the Epiphany (Adoration of the Magi) and his St. Jerome. These indicate that by this time the artist must have formulated his famous saying, used by academic painters in Europe for the next four centuries, that "painters should, in their figures, show those actions and emotions which through gestures best indicate the state of the soul."

In the period of warfare and fright that afflicted Florence after the Pazzi conspiracy of 1478, there was a general exodus of the best artists. Leonardo himself in 1482 went to Milan, where he stayed till 1500. There he reached new heights in his artistic career with the creation of the Madonna of the Rocks and the Last Supper.

In the Milanese years, Leonardo broadened his knowledge of anatomy. He projected a hypothetical plan of research with imaginative anatomical drawings. These start with the famous coition sheet from the Windsor collection. The drawings show considerable acquaintance with the anatomical studies of Galen. Among his notes one also finds references from Pliny and Celsus, both of whom probably had a powerful influence on Leonardo's early medical studies. We know that he owned a copy of Pliny's *Historia Naturalis*, which was published in an Italian translation by Jenson in 1476. The first printed edition of Celsus had appeared in 1478 in Florence, where Leonardo may well have taken part in discussions of it.

One of Leonardo's notebooks, dated April 2, 1489, begins with pictures of the skull and the discovery of the sinuses. Over the next few years, he slowly advanced, through dissection after dissection, to the facts connected with the structure of the skeletal, muscular, genitourinary, and respiratory systems. Eventually he undertook a profound study of the nervous system. All his studies, seemingly, were stimulated by two goals: to discover the causes of life and death, and to find "how the soul gets into the body and acts upon the body." The last, as his notebooks show, was part of a train of thought which was to lead him to studies in physiologic psychology beginning with experiments upon the spinal cord of the frog, to discoveries concerning the functions of the various parts of the brain, and to an important demonstration of the ventricles of the brain.

The need for his studies in anatomy and psychology he could rationalize in terms of questions concerning the display of varying emotions useful in perfecting his paintings. However, by his thirty-fifth year, using introspective methods, he moved over into the field of psychotherapeutics with a kind of self-psychoanalysis carried on through associational word lists combined with artistic creations. Thus, there is considerable support for calling Leonardo the founder of art therapy.

Around 1501 Leonardo returned to Florence. He lived for a time as a guest in the cloister of the Servite friars of Ss. Annunziata, where he probably began work on the cartoon for the St. Anne-Madonna. Later, he moved his studio and held classes within the walls of the convent hospital of Santa Maria Nuova, an environment favorable to research. Again

he turned to his work in anatomy, dissecting, and teaching. In 1508, during a visit to Milan, he presumably met Marcantonio della Torre, professor of anatomy at the University of Pavia, and discussed his work on anatomy with that brilliant young man. During these years he worked particularly on those studies in embryology whose completion around 1510 he celebrated by painting several embryos in the foreground pool of the St. Anne-Madonna picture.

In 1513, Leonardo went to Rome to serve General Giuliano de' Medici, brother of Pope Leo X, who sought his talents as a military engineer. Leonardo turned then to the final feature of his anatomic research, an essay on the lungs, trachea, and larynx, which he entitled *De Vocie.* He soon saw that the politically centered life of Rome would not allow the time and concentration necessary to complete for printing his work on anatomy, so he sought, as his final patron, the French king, Francis I. This enlightened monarch provided him with a small chateau at Cloux near the royal castle of Amboise. Here for the last four years of his life, Leonardo, always desiring to be useful, finished his great work on anatomy, and apparently arranged the pages in logical order. On October 10, 1517, Cardinal Luigi of Aragon and his secretary, Antonio de Beatis, visited Leonardo and reported that the old man, although slowed down in his painting by a paralyzed right hand, could still draw. Leonardo, according to de Beatis, showed his visitors his detailed writings on anatomy with his illustrations of "limbs, veins, tendons, intestines and all else there is to discuss in human bodies, such as had never been done before.... We saw all this with our own eyes. He said that he had dissected more than thirty bodies of men and women of all ages. Also he has written of the nature of water, of divers machines, and of other things which he has set down in an endless number of volumes in the vulgar tongue, which if published would be profitable and delightful."

The significance of Leonardo's anatomical discoveries has been made clear by Dr. Elmer Belt in his book *The Anatomy of Leonardo da Vinci,* which coordinates the findings of several anatomists who at different times have published the splendid collection of anatomical manuscripts at Windsor Castle. Dr. Belt lists thirty-three discoveries first found in Leonardo's research.

At least as early as the period of his apprenticeship to Verrocchio, the young Leonardo was also interested in botany. The evidence is scattered all through his notebooks, in drawings of flowers and plants, especially those of a medicinal nature. His religious paintings gave special scope for this interest, since medicinal plants and fruits played a prominent role in the religious symbolism of the day. The first of these paintings may have been the Madonna with the Pomegranate now in

the National Gallery in Washington. Another was the Annunciation, now in the Uffizi Gallery of Florence. The one most remarkable for its plethora of medicinal plants is that which he painted after going to Milan, the Madonna of the Rocks, now in the Louvre. Here some twenty varieties of healing herbs and flowers may be studied along with other clumps of plants and fruits found near Leonardo's home in Vinci to this day.

During his final years at Amboise, Leonardo completed a painting, now called the Bacchus, which was planned as a St. John. The grotto in which the St. John-Bacchus sits is carpeted with medicinal herbs. It is apparent from some notes written at this time that Leonardo had made a collection of healing herbs which he desired to print in the form of an herbal. Most of these pages, like many others from Leonardo's manuscripts, unfortunately have been lost.

The medicinal herbs so frequently seen in Leonardo's paintings are another example of his interest in medicine and pharmacy. It was especially in his early years in Florence, when that city was becoming a world center of the drug trade, that he seems to have worked in close connection with the apothecary's trade. The first sixty pages of his notebooks (dated before 1480 by Calvi) show inventions associated with an amazing number of the professions to which apothecaries catered, ranging from hairdressers and paper makers to cutlers and tennis ball makers, as well as the master painters of St. Luke's Guild. As late as his second Florentine period (probably between 1502 and 1511 as Cianchi has pointed out), Leonardo built a color- and herb-grinding mill in one of his father's houses at Vinci. It was so well constructed that it continued to function until 1905. The mill pond is still replenished with water from the springs of the brook which runs through the valley behind Leonardo's birthplace. Conducted through an aqueduct that was probably constructed by Leonardo, the water is part of the supply of Vinci today.

Leonardo's notebooks at this time also disclose some of his theories about drugs. He apparently used prescriptions taken from Pliny with whom he sometimes disagreed. Generally, however, his philosophy of medicine seems in accord with that of Pliny who had written that "wax salves, poultices, plasters, eye salves and antidotes were not made by the Divine Mother who created the universe; they are inventions of the laboratory or more correctly of human greed." Leonardo had the utmost respect for the *vis creatrix naturae*. He tested prescriptions with his scientific methods, comparing the quack salvers of his day with alchemists and astrologers, for whom he had little respect. Leonardo applied the medical philosophy of Pliny and Celsus, which he summarized in his notes with these words: "The greatest good is wisdom, the greatest evil the pain of the body," and "Medicine is the repair of

unequal elements, sickness is the discord of elements fused in the vital body."

Leonardo's abilities also took him into the field of sanitary engineering. For Galeazzo da Sanseverino's famous horses he planned a sanitary stable. After an outbreak of the plague, his significant knowledge of architecture and ctiy-planning led Leonardo to design not only hygienic villas for the nobility but a sanitary city. The baffling problem of sanitation in the medieval city revolved mostly about the manure and garbage which littered the streets. For this problem, Leonardo planned a three-level traffic system with a subway canal for the transportation of produce and the removal of garbage, a street for commerce, and an elevated promenade.

In the last years of his Milanese period, Leonardo apparently had acquired enough knowledge of canalization so that the Sforzas employed him on the Martesana Canal and on various irrigation projects. With this background early in the summer of 1502 he went to Piombino to study the drainage of the marshes. In 1503 he prepared plans for canalizing the Arno as a combined transportation, flood control, and power project very much like the Tennessee Valley Authority in our own day. He even envisioned an entire series of waterways between Pisa and Rome which would have been of very substantial commercial benefit to several cities. With some public health knowledge derived from reading Vitruvius, Leonardo had come to associate malaria with marshes. Drainage of the lakes and swamps near Pisa and Vinci was therefore made part of his general project. Similarly, when Leonardo went to Rome in 1513, he was interested in a project to drain the Pontine Marshes. Although he never saw the connection of malaria with the anopheles mosquito nor understood completely the connection of plague with the presence of rats, he did know that a sanitary city was a plague-free city and that sanitation presupposed a good canal system.

It was at Cloux, across a little valley from the Castle of Amboise, at the age of 67, on the 23rd of April, in 1519, that Leonardo dictated his will. Nine days later he laid down his pen and on the 2nd of May, closed his eyes for the last time.

Twenty years later, if we are to believe Benevenuto Cellini, Francis told how much admiration he had for Leonardo. The king affirmed that no other man born ever knew so much about sculpture, architecture, and painting. Furthermore, he said that Leonardo was a very great philosopher. Since Leonardo had many times written with some variations that "To Live was to Know" and that "To See was to Know," perhaps one may best consider him as a seeing, understanding, philosophical man

gifted with two hands which could both draw and write and construct, and a brain in which all of the faculties symbolized by these two proficient hands were continually exciting and rejuvenating each other, so that life, to him was never for a moment dull. He had been true to his life's goals: "to be useful to all men," to believe "in the rigor of destiny." And, as he wrote in his notebook, "As a day well spent brings peaceful sleep, a life well toiled brings peaceful death."

Raymond S. Stites, Ph.D.

Assistant to the Director, for Educational Services
National Gallery of Art, Washington, D.C.

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CATALOG

Main Lobby

I: Medical Books in Leonardo's Library

1. Plinius Secundus, C. Storia naturale. Venice, Nicolaus Jenson, 1476 (Schullian 375)

2. Celsus, Aulus Cornelius. De medicina. Florence, Nicolaus Laurentii, Alamanus, 1478 (Schullian 140)

3. Regimen sanitatis Salernitanum. [Louvain, Johann de Paderborn, ca. 1480] With commentary attributed to Arnaldus de Villanova (Schullian 387)

4. Cecco d'Ascoli, 1269-1327. Lo illustro poeta Cecho dascoli: con el comento novamente trovato, & nobilmente historiato. [Venice, Melchiorre Sessa and Pietro dei Ravani, 1516]

5. Albertus Magnus, 1193?-1280. Liber aggregationis, seu Liber secretorum de virtutibus herbarum lapidum, et animalium quorundam. [Venice, Bartholomaeus de Zanis, not before 1487] (Schullian 12)

6. Rhazes, 865-925. Liber tertius Almansori aut Cibaldoni. [Venice, Baptista de Tortis, about 1493] (Schullian 398)

7. Platina, Bartolomeo, 1421-1481. De honesta voluptate et valetudine. Venice, Laurentius de Aquila and Sibyllinus Umber, 1475 (Schullian 369)

8. Crescenzi, Pietro de, 1230?-1310? Il libro della agricultura. Vicenza, Leonardus de Basilea, 1490 (Schullian 156)

II: Books Leonardo Mentions Having Read

1. Vitruvius Pollio. De architectura libri decem. Strasbourg, Johann Knobloch, 1543 (First published 1487)

2. Rhazes, 865-925. Liber nonus ad Almansorem (cum expositione Joannis Arculani). Venice, Bernardinus Stagninus, de Tridino, 1493 (Schullian 402)

3. Mondino dei Luzzi, d. 1326. Anatomia corporis humani. Padua, Matthaeus Cerdonis, 1484 (Schullian 325)

4. Galenus. Opera. Venice, Philippus Pincius, 1490 (Schullian 199)

5. Hippocrates. De natura hominis. [Rome, Eucharius Siber, ca. 1483-90] (Schullian 242)

6. Benedetti, Alessandro, d. 1512. Historia corporis humani; sive, Anatomice. [Venice, Bernardinus Guerraldus, 1502]

7. Guy de Chauliac, 1300 (ca.) -1368. Chirurgia. Venice, Simon de Luere, for Andreas Torresanus, 1499 (Schullian 228)

III: Anatomical Works and Herbals

1. Ortus sanitatis. Mainz, Jacob Meydenbach, 1491 (Schullian 244)

2. Study of rushes (Ciperacee), by Leonardo (Windsor 12427)

3. Mansūr ibn Muhammad ibn Ahmad ibn Yūsuf ibn Faqīh Ilyās, fl. 1500. Tashrīh al-badan (Anatomy of the body). 4th of Muharram 894 [1488] (Schullian-Sommer P 18)

4. Ketham, Joannes de, 15th cent. Fasciculus medicinae. Venice, Joannes and Gregorius de Gregoriis, de Forlivio, 1500/01 (Schullian 270)

5. Genito-urinary system, by Leonardo (Windsor 12281r)

IV: Reproductions of Leonardo's Folios

1. Il codice Atlantico di Leonardo da Vinci nella Biblioteca Ambrosiana di Milano. Riprodotto e pubblicato dalla Regia Accademia dei Lincei sotto gli auspici e col sussidio del re e del governo. Milan, Hoepli, 1894-[1904]

Lent by Library of Congress

2. Les manuscrits de Léonard de Vinci ... publiés en fac-similés ... avec transcription littérale, traduction française, préface et table méthodique par M. Charles Ravaisson-Mollien. Paris, Quantin, 1881-1891. 6 v.

Tom. 2: Les manuscrits B & D de la Bibliothèque de l'Institut.

Tom. 6: Manuscrits H de la Bibliothèque de l'Institut; Ash. 2038 et 2037 de la Bibliothèque nationale.

Lent by National Gallery of Art

3. I manoscritti di Leonardo da Vinci delle Reale Biblioteca di Windsor: Dell' anatomia, fogli A, pubblicati da Teodoro Sabachnikoff. Transcritti e annotati di Giovanni Piumati, con traduzione in lingua francese, preceduti da uno studio di Mathias-Duval. Paris, Rouveyre, 1898.

4. I manoscritti di Leonardo da Vinci della Reale Biblioteca di Windsor: Dell' anatomia, fogli B, pubblicati da Teodoro Sabachnikoff. Transcritti ed annotati da Giovanni Piumate, con traduzione in lingua francese. Turn, Roux e Viarengo, 1901.

Lent by Yale Medical Library, Historical Library

5. Quaderni d' anatomia ... Fogli della Royal Library di Windsor ... Pubblicati da Ove C. L. Vangensten [et al.] con traduzione inglese e tedesca. Christiania, Dybwad, 1911-16. 6 v.

6. Il codice di Leonardo da Vinci nella Biblioteca del Principe Trivulzio in Milano. Transcritto ed annotato da Luca Beltrami. Milan [Hoepli] 1891.

Lent by Raymond S. Stites

V: Some Recent Studies on Leonardo

1. Belt, Elmer. Leonardo the anatomist. Lawrence, University of Kansas Press, 1955. (Logan Clendening Lectures on the history and philosophy of medicine, 4th series)

2. Belt, Elmer. Manuscripts of Leonardo da Vinci; their history with a description of the manuscript editions in facsimile [by Kate Trauman Steinitz] Los Angeles, Elmer Belt Library of Vinciana, 1948.

3. Braunfels-Esche, Sigrid. Leonardo da Vinci, das anatomische Werk. Mit kritischem Katalog und 175 Abbildungen. Basel, Holbein, 1954.

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5. Leonardo da Vinci. The notebooks of Leonardo da Vinci, arranged rendered into English and introduced by Edward MacCurdy. New York, Reynal & Hitchcock, 1939.

6. Leonardo da Vinci. On the human body; the anatomical, physiological, and embryological drawings, with translations, emendations and a biographical introduction by Charles D. O'Malley and J. B. de C. M. Saunders. New York, Schuman [1952]

7. McMurrich, James Playfair. Leonardo da Vinci, the anatomist (1452-1519). Baltimore, Carnegie Institution of Washington, 1930.

VI: Reproductions of Paintings

1. The Madonna with the Pomegranate. National Gallery of Art. Circle of Verrocchio, possibly by Leonardo.

   Courtesy of National Gallery of Art
   Model of frame by William Busch

   Enlargement of faces of Madonna and Christ Child (Photo H. Beville)

2. *Stemma*, or Coat of Arms, of Guild of Physicians and Apothecaries, Or San Michele, Florence. By Luca della Robbia.

3. Madonna of the Rocks (ca. 1483-86) Louvre Museum, Paris.

   Photo mural courtesy of Elmer Belt Library of Vinciana, University of California at Los Angeles

   Enlargement to show herbs (Photo Stites)

4. Epiphany, or Adoration of Magi (ca. 1478-80) Uffizi Gallery, Florence.

   Photo mural courtesy of Elmer Belt Library of Vinciana, University of California at Los Angeles

   Detail, actual size, to show studies in ecstatic expression (Photo Alinari)

5. St. Jerome (ca. 1478-80) Vatican Gallery, Rome.

   Courtesy of Elmer Belt Library of Vinciana, University of California at Los Angeles

6. Study of muscles of shoulder region (Windsor 19003)

Auditorium

Panel 1: Family and Town

1. Page of faces, inscribed *I del.* Clark date 1478, Stites date 1469 (Windsor 12276v.)

2. Ser Piero da Vinci and Leonardo. Dated 1478 (Uffizi 446)

3. View of Vinci with Mount Albano (Photo Stites)

4. Map of Arno valley, showing Vinci. Ca. 1502 (Windsor 12685N)

5. Detail, showing town of Vinci.

Panel 2: Medicinal Herbs and Fruit

1. Salvia leaf printed (Cod. Atl. 72v.a)

2. Star of Bethlehem, crowsfoot, wood anemone, and spurge. Clark date 1506 (Windsor 12424)

3. Spray of blackberry or raspberry. Clark date 1506 (Windsor 12425)

4. Wild strawsberry (Windsor 12423)

5. Dyer's greenweed and spray of oak leaves and acorns. Ca. 1495-96 (Windsor 12422)

6. Press for mounting or printing herbs (Cod. Atl.)

Panel 3: Medicinal Herbs

1. Bacchus-St. John, ca. 1510-19. Louvre Museum, Paris (Photo Giraudon)

2. Preliminary sketch for painting showing above figure as St. John at sanctuary of Sacro Monte at Varese. Drawing in sanguine on white paper.

3. Detail of herbs in foreground of Bacchus-St. John (Photo Giraudon)

Panel 4: Dietetic Dressing

1. Recipe for non-fattening salad dressing of herbs, vinegar, and bread (Forster Codex II, 60v; McCurdy, Notebooks, pp. 1181-82)

Panel 5: Paolo Toscanelli

1. Dr. Toscanelli, Leonardo, and device for demonstrating an eclipse. Stites date ca. 1472 (Cod. Atl. 320v.a, after Pedretti)

2. Dr. Toscanelli, from fresco by Alesso Baldovinetti.

3. Dr. Toscanelli, with representation of female reproductive organs (Windsor 12460r)

Panel 6: The Skull

1. Lateral view of skull with antrum of Highmore, 1489 (Windsor 19057v)

2. Interior lateral view of skull, showing meningeal vessels, 1489 (Windsor 19058r)

3. Interior view of skull, showing sagittal suture, 1489 (Windsor 19057r)

Panel 7: Anatomy of Expression

1. Terra cotta bust of Giuliano de' Medici, by Verrocchio and Leonardo, 1478. National Gallery of Art (Photo H. Beville)

2. Head of Nemesis from Giuliano bust (Photo Stites)

3. Statue of David and Goliath, by Verrocchio and Leonardo, ca. 1476. National Museum (Bargello), Florence (Photo Brogi)

4. Head of Goliath, by Leonardo, from statue of David and Goliath (Photo Stites)

5. Superficial and deep dissection of facial muscles (Windsor 19012v)

Panel 8: Skeletal System

1. Bones of lower extremity (Windsor 19011r; Sabachnikoff A, 12r)

2. Bones and muscles of leg (Windsor 19008r; Sabachnikoff A, 9r)

3. Thorax, pelvis, and spinal column (Windsor 19012r; Sabachnikoff A, 13r)

4. Bones of arm and hand to illustrate pronation (Windsor 19000v; Sabachnikoff A, 1v)

Panel 9: Nervous System

1. Early drawing, half hypothetical, of relationship of nerves to brain, heart, lung, and stomach. Clark date 1487. (Windsor 12627r; Quaderni 5:20v)

2. Continuation of hypothetical prevision (above). Clark date 1487. "Sense of touch, cause of motion, origin of nerves, transit of animal powers, genital power": written in forward hand (Windsor 12613v; Quaderni 5:21r)

3. Peripheral nerves of lower extremity (Windsor 19114r; Quaderni 4:9r)
4. Spinal column, with separate vertebrae (Windsor 19007v; Sabachnikoff A, 8v)

Panel 10: Blood Supply

1. Ventricles of the heart (Windsor 19119v; Quaderni 4:13v)
2. Exterior view of the heart (Windsor 19073v; Quaderni 2:4r)
3. Superficial vessels of arm (Windsor 19027r; O'Malley and Saunders, 298)
4. Arteries and veins of neck, showing effects of age (Windsor 19049v; Sabachnikoff B, 12v)

Panel 11: Muscular System

1. Muscles of lower extremity (Windsor 12625; Quaderni 5:22r)
2. Leg muscles suggested by copper wires (Windsor 12619; Quaderni 5:4r)
3. Anterior view of leg with dorsum of foot (Windsor 19017r; Sabachnikoff A, 18r)

Panel 12: Alimentary System

1. Alimentary tract, liver, stomach, spleen, and first drawing of vermiform appendix (Windsor 19031v; Sabachnikoff B, 14v)
2. Greater omentum and abdominal viscera (Windsor 19039v; Sabachnikoff B, 22v)
3. Portal vein, mesenteries, and diagram of greater omentum (Windsor 19020r; Sabachnikoff B, 3r)

Panel 13: Embryology

1. St. Anne and the Madonna, ca. 1504-10. Louvre Museum, Paris (Photo Louvre)
2. Detail of foreground pool with embryos and womb (Photo Stites)
3. Drawings of objects in foreground pool.
4. Drawings of embryos in 4 stages of development, from Leonardo's work in embryology.

Panel 14: Respiratory System

1. Lungs and trachea; heart, kidneys, and bladder. "Dust makes damage." (Windsor 19104v; Quaderni 3:10v)
2. Larynx, pharynx, and esophagus (Windsor 19002r; Sabachnikoff A, 3r)
3. Diaphragm in expiration and inspiration. Dated "on the 9th day of January, 1513." (Windsor 19077v; Quaderni 2:7v)

Panel 15: Florence

1. View of Florence
2. Close-up view of Campanile, with guild reliefs. Sculptures by Andrea Pisano (Photo Stites)
3. Close-up of relief representing physicians, by Andrea Pisano (Photo Stites)
4. *Stemma*, or coat of arms, of Guild of Physicians and Apothecaries, Or San Michele, Florence. Sculpture by Luca della Robbia, a Consul of the Guild.

Case 1: Grinding Mills

1. "Mill for grinding colors at Vinci" (Cod. Atl.)
2. Model of mill, by William Busch. Courtesy of Dr. Stites.
3. "How they make white in Flanders": apparatus for making white lead, used both as paint and as medicine. Ca. 1478 (Cod. Atl. 215c)
4. Model of apparatus for making white lead.

The Brain

5. Model of brain, showing ventricles.
6. Drawings of brain with optic chiasma. O'Malley date ca. 1490 (Windsor 12602r; Quaderni 5:8r)
7. Early hypothetical drawing to show location of *sensus communis* and connections with eye. O'Malley date 1490; Clark date ca. 1500 (Windsor 12603r; Quaderni 5:6v)
8. Brain with ventricles and central nerves: "Cast in wax through the holes at the bottom of the base of the cranium before cranium is sawn through." (Windsor 19127r; Quaderni 5:7r)

Panels 16-18: Genito-urinary System

These exhibition panels are presented through the courtesy of Dr. Elmer Belt, Los Angeles, California.

Panel 16

1. Vascular tree (Quaderni 5:1r)
2. Lower torso and extremities of man (Quaderni 5:23r)

Panel 17

1. Female genito-urinary sytem (Quaderni 1:12r)
2. Tracing of above (Quaderni 1:11r)
3. Brain and canals (Weimar Schlossmuseum)
4. Male and female genito-urinary systems (Weimar Schlossmuseum)
5. Uterus receiving organ (Quaderni 3:2v)
6. Coition figures (Quaderni 3:3v)
7. Coition figures, sagittal section (Quaderni 3:2r)

Panel 18

1. Male genito-urinary system (Quaderni 3:4v)
2. Right testicle and spermatic cord (Quaderni 3:5r)
3. Homologies of male and female organs (Quaderni 3:1v)
4. Abdominal cavity (Sabachnikoff B, 14r)
5. Fetus (Quaderni 3:8r)
6. Diagram of male genito-urinary system (Quaderni 5:25r)
7. External genital organs of the female (Quaderni 3:1r)

Panel 19

1. Fetuses and vulva (Quaderni 3:7r)

2. Veins of the leg (Quaderni 4:8r)

3. Left kidney and vessels (Sabachnikoff B, 13v)

4. Bladder and kidneys (Sabachnikoff B, 37r)

5. Male genito-urinary system (Quaderni 3:6r)

6. Sketches of male and female organs (Quaderni 3:12v)

7. Sphincter of the bladder (Quaderni 3:11v)

Case 2: Distillation Apparatus

1. Leonardo's drawing of furnace with double alembic (Cod. Atl. 335r.b)

2. Model of furnace, by William Busch.

3. Leonardo's drawing of water-cooled alembic (Cod. Atl. 400v.c)

4. Model of alembic, by William Busch.

Speculum

5. Early sheet of inventions with sketch of speculum *(l'specchulo)* and signature *Io Lionardo* (Cod. Atl. 379r.a)

6. Four completed devices: speculum reversed, saw, wire-drawer, and spinning bobbin (Cod. Atl. 379v.b)

7. Replica of ancient Roman speculum. Courtesy of Armed Forces Institute of Pathology, Medical Museum.

8. Model of Leonardo's speculum, by William Busch.

Panel 20: Facial Characteristics of Leonardo

1. Age ca. 20 (Windsor 12432r)

2. Age 26, dated 1478 (Uffizi 446)

3. Age ca. 55 (Windsor 12300v)

4. Age ca. 60 (Turin drawing)

5. Age ca. 64 (Windsor 12579r)

6. "The tired hand," beard, and nymph, ca. 1518 (Cod. Atl. 283v.b)

Panel 21: Sanitary Engineering and Flood Control

1. Lower end of canal from Florence to Pisa, ca. 1504 (Windsor 12683)

2. Valley of the Chiana from Borgo San Sepolcro to Arezzo, ca. 1502 (Windsor 12278r)

3. Coast below Rome from Terracino to Simonetta, ca. 1513 (Windsor 12684)

4. Hodometer: machine for measuring distances. Note right and left handwriting (Cod. Atl. 1r)

5. Excavating machine (Cod. Atl.)

6. Elevation for sanitary street (Ms. B, 36a)

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